Direction Leaflet Number Three

HOW TO COLLECT INSECTS AND SPIDERS FOR SCIENTIFIC STUDY

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A collection of insects and spiders, like almost any other collection, derives its value from its scope, its condition, and the extent and accuracy of the information which it conveys. A theoretically perfect entomological collection would contain many perfect specimens of both sexes of every existing kind, from every possible locality, and every day of the year, together with a complete account of the life history and habits of each creature. Of course, this ideal has not even been approached by the combined efforts of all the collectors since the beginning of systematic biology; but any student, professional or amateur, if he is a careful workman and an accurate observer, can contribute something toward its achievement. He may, quite possibly, discover one or more new species, although he must be very highly trained to recognize them. He is far more likely to record an old species from a new place, or to observe some familiar creature about its unfamiliar business. That is why the habit of note-taking is so important to the scientific collector. Virtually nothing is known about the private lives of the great majority of insects and spiders. Any one who watches them work in their natural habitats and writes down exactly what he sees, season by season, is certain, over a period of years, to amass a great deal of information hitherto unknown.

This kind of work is an important part of the science of Ecology. To do it, you need patience, persistence, and an orderly method of recording your observations. You must keep at least one specimen associated with each item of information, so that no mistake in identity is possible, and bits of an insect's story picked up at various times and places can be assembled with certainty, even though you may not know the creature's name. The species must, however, be identified before you attempt to make your observations known.

Many beginners will find it interesting and profitable to establish correspondence with professional or advanced amateur entomologists of kindred tastes. Almost any University, Natural History Museum, Entomological Society, or State Department of Agriculture could put you in touch with some of them. They are happy to guide your choice of technical literature, and to help with difficult identifications. If you happen to make an important discovery, they can tell you what to do about it. In return, they may ask you for duplicate specimens of interesting species and permission to quote you, among other observers, on topics pertinent to their own investigations. This amicable association is one of the pleasant things about a scientific hobby, and a source of satisfaction to both the beginner and the experienced student.

WHEN AND WHERE TO LOOK FOR INSECTS

Unlike some other animals, most insects stay in one general locality day and night the year round, and may be found at any time by a collector who can recognize them in all stages of development, and who knows their habits well enough to guess what they are doing under the prevailing circumstances. To be sure, you can catch more specimens per hour of collecting in summer than you can in winter; and although many insects are abroad by night you are less apt to see them than the diurnal species; but out-of-season and odd-hour collecting are much more likely to produce unusual results.

There are more species of insects in the world than of all other animals together, and probably more individual insects than any other kind of creature large enough to see with the unaided eye. As might be expected of so great a population, they inhabit practically every habitable portion of the globe. With the single apparent exception of the depths of the sea, all imaginable and some unimaginable places have their six-legged residents.

Insects abound, for instance, upon and beneath the earth itself. You can find them scuttling over bare rocks, the open sand of beaches and deserts, the loose soil of gardens, the beaten paths of the country, and the pavement of city streets. They creep about under the grass of lawns, the moss of forests, and the lichens of the arctic tundra. They lurk beneath stones, logs, compost piles, fallen leaves, and flood derbis of river and seashore. In arid regions, the roots of plants

may harbor a multitude. Burrowing species make their homes in humus, sand, packed clay, or the sodden mud of river banks and marshes. In the dry dust under porches, or in the shelter of cliffs and the mouths of caves, Ant-lions make their little sand traps. In the depths of caves, perpetual darkness hides a curious insect fauna of its own, a limited but specialized population which should be investigated whenever opportunity arises.

Most adult insects fly, and when the air is warm enough it swarms with them, especially in the vicinity of flowers. In our northern Spring, the inconspicuous blossoms of shade trees are well attended. All summer long garden and meadow bustle with bees, flies, wasps, and butterflies from dawn till dusk; and, with twilight, the crepuscular and nocturnal forms begin their night's activity. Large numbers of these are attracted to lights, and can be trapped, netted under street lamps, or picked off of window screens. Adults of species which are aquatic when immature may often be taken on the wing above ponds and streams, while predaceous species are frequently found "hawking" along hedgerows, roadsides, and forest paths and clearings. Barnyards, too, are worthy of attention, yielding, especially, biting and parasitic flies, and such species as may feed or breed in filth.

Lakes and mud puddles, rivers and ditches, fresh water in any quantity is well provided with aquatic insects. So is the salt water of the tidal zone. Some of the creatures skate upon the surface without wetting their feet. Some dive when alarmed. Some are skillful swimmers, while others creep upon the bottom, burrow in mud, bore in aquatic plants, or cling tenaciously to the polished stones of swift-running mountain streams. There are insects in arctic waters which are frozen solid a great part of the year, and in thermal springs so hot that few forms of life can endure them. Rainwater caught in footprints, tin cans, hollow trees, and eaves troughs soon swarms with insect larvae. Even a neglected bowl of flowers in your parlor can harbor a generation of mosquitoes.

Plants of every size and condition, from the little green algae on the tree trunk to the great tree itself, afford room and board to countless six-legged "guests." Seed, seedling, growing plant, mature, dying, dead, dry, decaying, rotten, and reverted to the earth, plants in all stages support insects of all stages, wherever plants and insects grow. Leaves, flowers, and fruits may be devoured entire or delicately mined from within. Sap and nectar may be sucked, twigs pierced, stems hollowed, pith excavated, bark gnawed, trunks and branches riddled, and roots bored. Most of these activities leave traces by which the astute collector may discover the actors. While looking for them, you will also come across a variety of casual visitors, nocturnal creatures passing the day in a convenient crevice, fleet-winged species resting in the sun, as well as predators and parasites deliberately seeking the more permanent residents.

Plant galls amply repay investigation, producing not only the original causative insect, but also parasites and the uninvited guests called inquelines. Since all such creatures are small, and most of them minute, it is necessary to take the galls home and rear their inhabitants in captivity to be perfectly certain of their association.

Animals, too, have their hexapodous associates. Mammals, birds, reptiles, and even fish, are subject to the attack of parasites, external and internal. Many of these are specific to a particular host, and a systematic examination of all available animals will reveal a considerable assortment. Insects themselves are almost all parasitized by other insects, and there is a great deal of interesting work to be done in establishing their relationships.

Dead animals, and even their dry bones, attract a different set of insects seldom to be found elsewhere; flesh flies and carrion beetles among others. And, if you are not too fastidious to look, dung also yields its own unique and numerous inhabitants.

Not even Man himself escapes the attention of insects. Some of them simply come for dinner, others take up permanent residence and cannot be evicted without violence. Buildings erected by Man for his own accomodation appeal to insects looking for a good warm place to spend the winter, and some of them like it so well that they stay the year round. All the food gathered and stored by Man for his future sustenance sustains, as well, a numerous hexapodous company. His rugs and clothing, his books and furniture, the very roof over his head and the floor beneath his feet may look like lunch and lodging to one insect or another.

In short, there is, for practical purposes, no place a collector can look in which an insect may not occur. Some localities are richer than others, and a habitat which is thronged this week may be deserted next, but until you have searched a place thoroughly you cannot be sure whether or not insects are hidden there. When you have collected in any area a long time, you will learn what hours, spots, and atmospheric conditions are likely to be most productive. But do not let this knowledge limit your activities. The species aboard in less favorable circumstances may differ from those of the rush-hour crowd. On the other hand, do not ignore a species simply because it is extremely abundant. It may be a strongly seasonal form, available in the adult state for a few days or a few hours only, out of the entire year; or perhaps it is one with a long life-cycle, maturing only at intervals of several years. It could be a very long time before you see the animal again.

LOOKING FOR SPIDERS

All spiders are carnivorous, feeding almost wholly upon insects. They can not fly, and although some of them are expert divers, none of them is truly aquatic; but, within these limits, they follow their insect victims everywhere. Some of them spend the day in silk-lined burrows, underground. Others hide in caves, in cracks, and under all kinds of debris. The herbaceous plants of marsh and meadow shelter a large population as do the trees and bushes of forest and wayside. Almost any flower may contain a camouflaged spider lying in ambush for the unwary fly. The conspicuous siken nets, funnels, and egg sacs of many species will lead you to their inconspicuous owners, and a search of barns, attics, and cellars will produce semi-domestic varieties.

Any person making a general collection of insects is certain to turn up a great many spiders in the process. Since these have been less studied than insects, the chance of finding new species is considerably greater, while even less is known about their habits than about those of insects. If you are not interested in spiders yourself, you can do a service to Science by catching them anyhow, and donating them to some learned institution; or you might profitably establish a trading agreement with an arachnologist in some other part of the world. An advertisement in a scientific journal or popular magazine of natural history would probably uncover a number of people eager to "swap" insects for spiders, the creatures of one area for those of another, or an assortment of species for those of a particular family or genus. Acquaintances formed in this manner may improve with years, and add both to the scope of your collection and to the interest of your hobby.

COLLECTING PROCEDURES

Every serious collector takes pride in the perfection of his specimens. With a collection of insects or spiders, the achievement of this perfection begins in the field. The creatures must be caught carefully, killed quickly, and packed securely, if they are to reach the laboratory in good condition.

The great variety of collecting techniques employed by expert collectors are individually derived from the few basic methods here described. These are dictated by the physical nature of the specimens, their habits, the places from which they must be extracted, and the tools and materials most readily available to the collector. In making a general collection, you will probably, sooner or later, use all of them, but it is not recommended that you try to do so all at once. You would be so hampered by the weight and bulk of your equipment that a maggot could escape you. Much better try them in succession, carrying a minimum of impedimenta, until you have learned the possibilities and limitations of each and which are most suited to your own needs and abilities. As you become proficient, you will devise improvements of your own, and evolve a collecting kit adapted to your personal requirements.

HAND PICKING

This is the original collecting technique, and it is still satisfactory for many insects and spiders. The necessary equipment is equally fundamental, consisting of good eyes, nimble fingers and the following simple articles.

FOR WET COLLECTING

1. Several small bottles with tight stoppers.
2. A supply of preserving fluid.
3. A small water-color paint brush.

FOR DRY COLLECTING

1. Several killing jars, ethyl acetate or cyanide type.
2. Storage boxes with packing material.
3. Some paradichlorobenzene moth crystals.

GENERALLY USEFUL

1. Notebook and dark pencil.
2. Small slips of paper, for locality labels.
3. Small metal boxes, for transporting live specimens.
4. A small, wide-mouthed bottle and a card large enough to cover it. This is used to catch dangerous specimens.
5. A pair of forceps, slender and pointed.

Hand picking is applicable to a great variety of insects and spiders at some stage of development or under some conditions. Many species are naturally sluggish, or even immobile; and few of the wingless varieties are fast enough to escape, when alarmed, if you can manage to keep them in view. Even the swiftest of the winged kinds are easily taken when sleeping, preoccupied, or numb with cold.

Most species large enough to be grasped without injury may be simply picked up with the fingers and dropped into the collecting jar. Wasps and bees, true bugs, Black Widow spiders, and other creatures convicted or suspected of biting or stinging, should be handled with more care. If such a specimen is found in a suitable location, you may be able to catch it between the mouth of the killing jar and its cover. In other places the bottle and card may be more practical. Put the mouth of the bottle over the specimen, slide the card under it, uncover the killing jar, place the two bottles mouth-to-mouth, withdraw the card from between them, jolt the specimen into the

killing jar, and clap on the lid. If you are dexterous with the forceps, you may prefer to use it for handling dangerous species, as well as those too small or too inaccessible to be siezed between the finger and thumb.

Creatures too soft-bodied to dry without distortion must be collected and preserved in liquid. These include all spiders, the eggs, larvae and pupae of most insects, and the adults of some. A few hard-bodied insects that are black or dark brown in color, such as dung and water beetles, can stand wetting and may be collected in liquid and subsequently removed, pinned, and dried in the usual manner. Hairy, scaley, or delicate-winged species are collected in liquid only when wanted for dissection, as their appearance is irreparably ruined by such treatment. All species, hard or soft, which are so small that they must be mounted on microscope slides are properly collected wet. Caterpillars which are to be inflated can be collected in liquid, but the color will be better if they are brought into the laboratory alive and dropped into boiling water, or gassed in the dry killing jar, like a hard-bodied insect, and blown immediately thereafter.

A very large number of preserving fluids have been concocted by learned collectors, each claiming some particular advantage. Their formulae are available in technical publications. This museum, however, uses nothing but 95% pure ethyl alcohol, somewhat diluted with water for most purposes. Unfortunately for the amateur entomologist, pure ethyl alcohol, 190 proof grain neutral spirits, is subject to a federal liquor tax which makes its price prohibitively high. Its sale is further restricted by State regulations. In New York State it cannot be purchased without a Doctor's perscription or a permit from the State Liquor Authority. Many scientific institutions, such as university laboratories, hospitals, and museums, have permits, and are also tax exempt, but they may be called to account for every pint they use. If you can arrange to obtain your alcohol from such a source, you are in luck. If you cannot, go to the nearest drug store and find a rubbing-alcohol compound containing 70% of ethyl alcohol. This will be a satisfactory killing fluid for all but the most delicate species. As a preservative, it is just barely strong enough. When a small bottle-full is diluted with the body fluids of several large specimens, it ceases to be effective, and must be replaced. Change the alcohol on even a few small specimens at least once, that on a large lot two or three times, within a few days of capture. Thereafter, renew the liquid whenever it becomes discolored.

For very tiny thin-skinned species, such as aphids and thrips, use a killing fluid containing, by volume, one part of water to three of 70% alcohol, replacing it with straight 70% alcohol the following day. This "stepping up" minimizes the shrinkage caused by sudden removal of water from the tissues.

"Completely denatured alcohol" contains 95% of ethyl alcohol, rendered impotable by the addition of a little wood alcohol and gasoline. You can buy it at many large drug stores, or order it from a chemical supply house, and dilute it as you would pure alcohol to serve your several purposes. To make a killing fluid for delicate specimens, add 6 parts of water to 7 of alcohol. For general collecting, and to preserve very small species, use 2½ parts water to 7 of alcohol; and for preserving those of large or moderate size, 2 to 11. Always replace the killing fluid by the more concentrated preserving fluid within a day or two. The stronger the alcohol, the less frequently must it be changed because of dilution by the natural moisture of the specimens, but too strong a mixture will make the creatures brittle. Laboratory procedures for dealing with soft-bodied arthropods are discussed in Leaflet Number 6.

To look well, a collection of alcoholic specimens should be stored in bottles of uniform design and a limited number of sizes. Those used as standard in this Museum are lipped vials with corks, 2 dram size for small and medium sized species, 4 dram for large ones. Such vials are obtainable at drug stores and scientific supply houses. When purchased in quantity, the price is surprisingly low. Doubling as collecting bottles, a pocketfull of these little storage vials have several advantages over a single large collecting jar. For one thing, you cannot accidentally spill your whole day's supply of alcohol at one time. For another, each species, colony, or associated group of creatures can have a bottle and label to itself. Do not forget the label, date, locality and observations, written in soft pencil on a small slip of paper and placed inside the bottle with the specimens. Color notes will be particularly valuable, as vivid or delicate hues are bleached by alcohol, while creatures which are pale or colorless gradually turn dark brown.

Both the discoloration and the distortion of liquid preservation will be less if you bring back your specimens alive, and kill them by stewing in water heated to just below the boiling point. Let them simmer for five to fiteen minutes, according to size. Then, if they are large enough to handle, puncture each with a needle, to relieve internal pressure, before transferring them to alcohol. Stewing is highly recommended by specialists in the study of larvae, particularly for the preparation of grubs and other wax-white animals. When the beauty of the specimens is more important than economy of time, it certainly repays the extra effort.

If a tight-corked bottle is more than three quarters full of liquid, the air pressure caused by the insertion of the stopper may be great enough to force it out

again, especially if the stopper is wet. Fill your collecting vials about two-thirds full, to allow plenty of room for both specimens and air space.

If, through a shortage of bottles or the unavailability of small ones, you should find it necessary to put more than one group of specimens in a container, be careful to keep them well separated from each other, and inseparable from their proper label. When using a wide mouthed jar, tie up each lot, with its label, in a small twist of cheese cloth. Partition a tall narrow bottle with plugs of cotton or soft paper. To facilitate subsequent unpacking, put two distinct wads between each two successive layers of specimens, so that, should the claws of the creatures become entangled in the fibers, you will not have members of two lots clinging to opposite sides of the same bit of packing.

Fig. 1. Using the wet brush to handle minute insects.

Many of the insects and spiders collected into alcohol are too small to be grasped with the fingers, and too delicate to be siezed with forceps without danger of crushing. These may most easily be captured by use of a camel's hair brush. A number one or two round water-color brush is perfect. Moisten the brush with killing fluid and sweep up the specimen with its tip, using a sideways prying motion if the creature is tenacious. Once it has released its grip, the specimen will adhere to the wet bristles until it is washed off in the collecting vial. In a pinch the tip of the forceps or the end of a twig can be employed in the same manner.

Although small bottles of alcohol can be carried loose in the pocket with comparative safety, those who specialize in this kind of collecting sometimes use a hunter's vest, carrying one vial in each of the cartridge pockets with which the front of the garment is covered. In buying a vest for this purpose, insist on complete pockets, closed at the bottom, and be sure to use vials that fit them precisely, so as not to fall out when you bend over.

Insects sufficiently hard-bodied to be mounted upon pins are usually killed in a dry killing bottle, and all hairy or scaley ones, moths, butterflies, and true flies especially, must be so collected unless intended for dissection. The construction and use of the Ethyl-acetate or Ether type of killing jar is discussed in Leaflet Number 1; the traditional cyanide jar in Number 7. Although such bottles anesthetize an insect quickly, resistant species may revive if removed less than half an hour after capture. It is unwise to overcrowd a jar, both because the creatures may damage each other while still squirming and because the accumulated moisture from a large lot may condense on the inside of the bottle and stain the specimens. Consequently, on a collecting trip of any duration, it becomes necessary to carry several killing jars to be used in rotation. It will also be advantageous to provide jars of various sizes, so that small and delicate species need not be lost or damaged among the large and durable specimens in a common jar. For a day's collecting you might use one half-pint bottle, for very large specimens; two four-ounce bottles, for those of average size; and several four-dram vials for the very small. Moths and butterflies, being prone to shed their scales, must have a special bottle of their own which is not used for other insects. Since you should never touch them with your fingers, you are not likely to take many Lepidoptera by hand-collecting, although it is possible to knock a sleeping moth into the killing jar without picking it up, or to capture an occasional butterfly by the bottle-and-card technique. Similar precautions should be observed with flies, especially the very hairy ones, the handling of which is described below under "Aerial Collecting."

Specimens should be left in the killing jar no longer than necessary, since prolonged exposure to the lethal fumes may cause discoloration, and the constant agitation to which the bottle is subjected in the field may so batter the catch that it cannot be identified. Only experience can teach you how many specimens a killing jar can safely accommodate, and for how long, but from time to time you should stop adding insects to a bottle, and about half an hour later transfer its contents to a storage box for safer transportation.

The simplest effective field storage box is a strong, tight, pocketsize container filled snugly with layers of thin glazed cotton or cellulose packing material cut to fit exactly. Fill this box from the bottom up, placing the specimens, one deep, between the layers of cotton, and always replacing all the packing before closing the lid, so that the specimens cannot bounce around

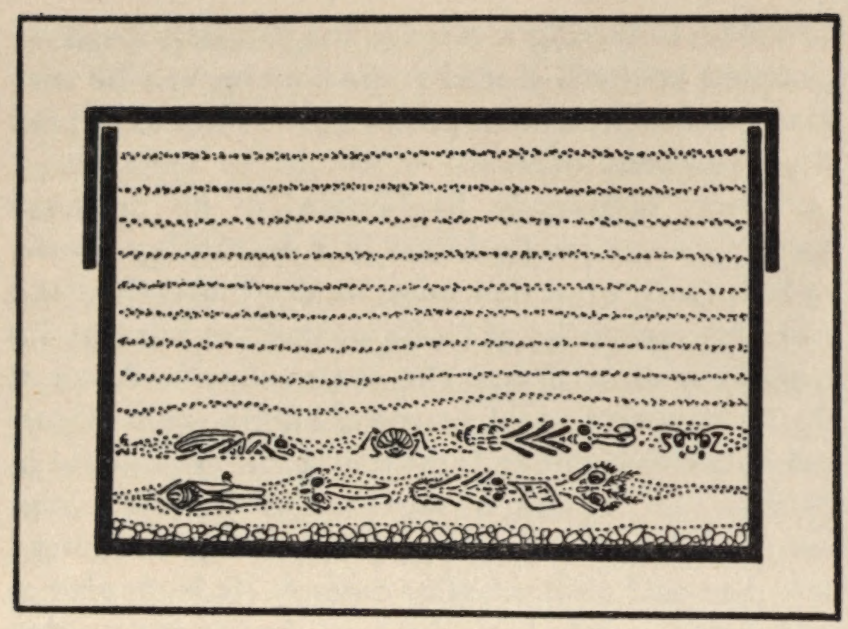

Fig. 2. Diagrammatic vertical section of a field storage box, showing the insects packed between layers of cotton.

in the box. If you put a spoonful of paradichlorobenzene under the bottom layer at the beginning of your trip, its fumes will serve to dispatch any specimen which may not be quite dead when packed. Remember the label, which should be part of every layer, or at least of the top layer of every lot.

An alternate method of packing, perferred by many experienced collectors, is to wrap the specimens in paper envelopes or tubes. The large-winged species requiring envelopes are commonly taken with a net, and their treatment will be described under "Aerial Collecting." Thick bodied and small-winged species, beetles, bugs, hoppers, bees, and many others, may be stored in cylinders made by wrapping a slip of paper about three inches square around a pencil, stick, or any convenient object, and crimping the ends shut, as shown in fig. 3. Before rolling the cylinder, write the data relative to its contents on what will be the outside edge, so that it can be read without unrolling. Fill each cylinder so tightly that the specimens cannot rattle, and keep the tubes themselves from banging around in the storage box by wedging them in with a wad of cotton or crushed tissue paper. When there are enough papered specimens to fill the box entirely, no other packing need be used.

Unless the specimens are to be mounted immedi-

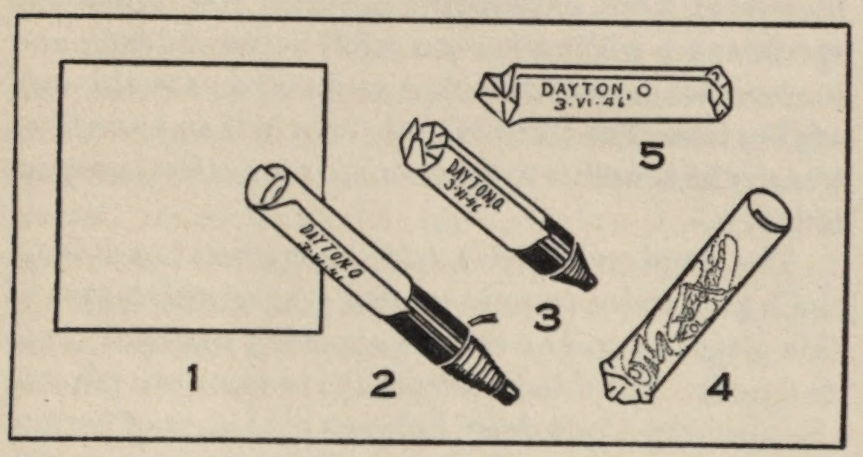

Fig. 3. Steps in making paper cylinders for wrapping large, hard-bodied insects.

ately, the storage boxes should, upon return from the field, be left open in a warm place until the insects have dried most thoroughly. In the moderately dry summer weather of the eastern United States, this may take only a day or two, but very large species may require from one to two weeks. In the humid tropics, forced drying is frequently necessary. When using an oven to dry insects in a hurry, keep the temperature low, about 100 to 120 degrees F. You do not want to cook your catch before it dries.

When the insects are dry, put a teaspoonful of "Para" into each box before closing, to keep out mold and insect-eating beetles and ants. If the lid is not very snug, it will be safer to keep the small storage boxes in a large metal can or cabinet which is tight enough to keep out entomophagous pests as well as mice. So stored, the specimens will keep indefinitely

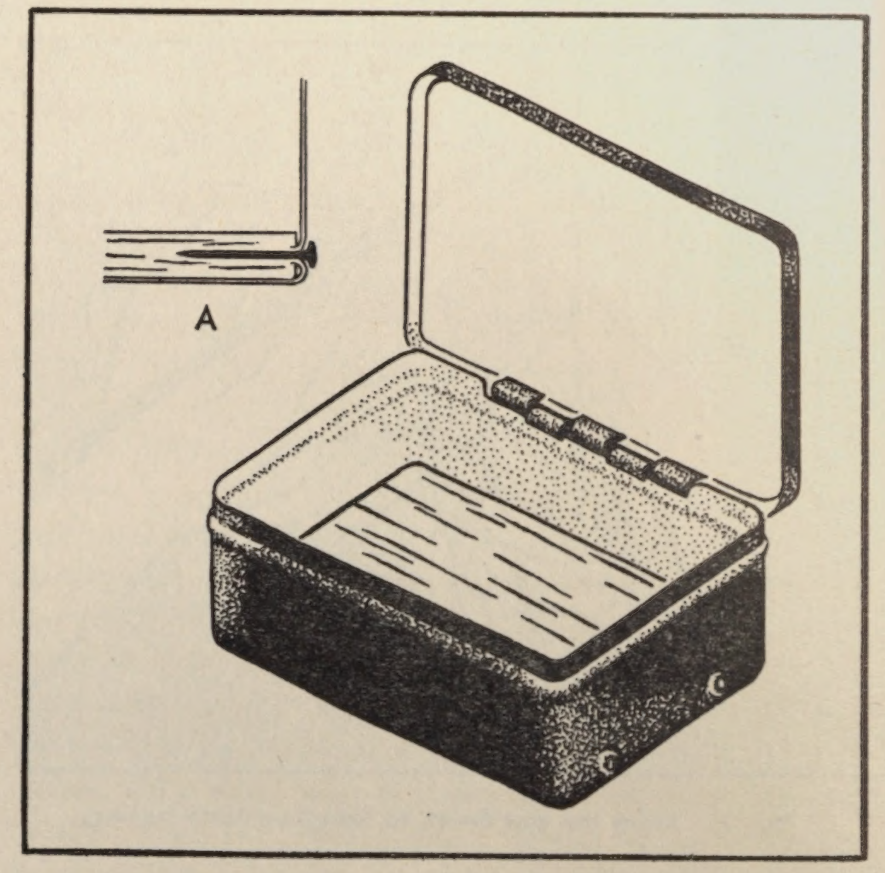

Fig. 4. A pocket relaxing box.
A. Detail of an easy method of securing the absorbent lining.

and need only be relaxed to be mounted. This process is described in Leaflet Number 4.

If the specimens are to be mounted on the day of capture, you can keep them soft and workable until wanted by the use of a pocket relaxing box. Make this of a thin metal box with a tight hinged lid, such as is used for packing ginger, nuts, and some kinds of cigarettes. Obtain a piece of balsa wood or cork about a quarter of an inch thick, and as large as the inside of the box. Fasten it into the bottom of the box by means of a few slender brads driven into the edges from outside, as shown in fig. 4. At the beginning of a collecting trip, moisten this lining, wipe off any excess water, and fill the box with layers of cotton or with papered specimens in the ordinary way. When

you return to your base in the evening the morning's catch will still be pliable and ready for mounting.

Many of the immature insects discovered in the field will be unidentifiable unless reared to maturity in the laboratory. It is easy to get them there alive and well if you have small metal boxes in which to carry them. Baking powder tins, cocoa cans, and salve boxes serve admirably. For convenience in carrying, select them to nest one inside the other when not in use. To prevent injury by jolting, give each creature something immovable to which it can cling, a bunch of leaves, a piece of bark, or whatever the tastes of the species may indicate. A crumpled piece of paper toweling, slightly damp, will also do. Subterranean insects can be packed in their native earth. Whatever material is used should fit the box so tightly that it cannot shift.

Unless otherwise specified, insects and spiders secured by more complicated methods should be killed and packed in the same ways as those which were taken by hand.

is particularly suitable. A killing jar which has contained Lepidoptera should not subsequently contain any other kind of insect as the loose scales cling to oily or hairy specimens so thickly as to obscure their characters and spoil their appearance. Although they can be packed between layers of cotton, moths and butterflies will rub less if each is stored in an individual envelope. Cellophane and waxed paper envelopes of convenient sizes are sold by wholesale stationers. The triangular paper envelope, traditional among Lepidopterists, is shown in fig. 5. Whichever you use, write the data on the outside before putting the insect inside, with the wings folded together over the back.

The very small moths called Microlepidoptera are largely nocturnal, and are commonly taken in light traps. However, when collecting by day, especially in the late afternoon or early evening, you are certain to flush a number of them. If you are prepared to handle them properly, these make the more perfect specimens. Since the insects are tiny and very fragile,

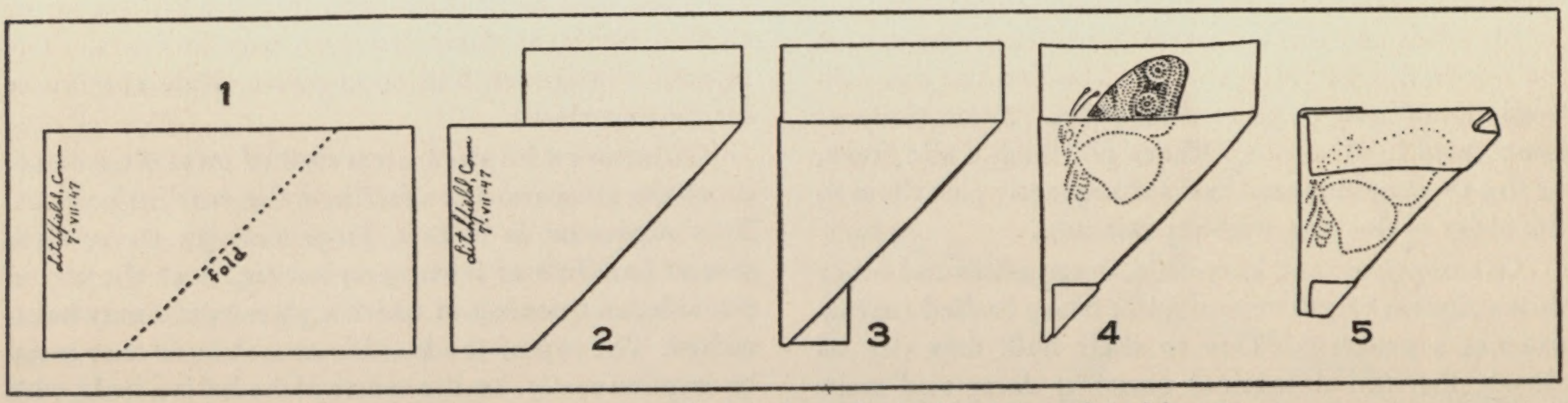

Fig. 5. Steps in making triangular envelopes for packing large-winged insects.

AERIAL COLLECTING

The most conspicuous and characteristic tool of the Entomologist is the insect net, used to capture insects on the wing. The construction and operation of such nets is discussed in Leaflet Number 2.

The size and delicacy of the aerial net confines its use to fairly open country, fields, gardens, roadsides, clearings, deserts, beaches, and the like. Fortunately, it is in just such places that flying insects are most commonly observed. Although beetles, grasshoppers, true bugs, and others are not infrequently taken in flight, the majority of specimens so captured will be moths and butterflies, true flies, dragon and damselflies, wasps and bees, and members of some minor orders.

Of these, moths and butterflies require the greatest care. If the tiny scales with which these insects are clothed become lost, the color pattern goes with them. They rub off very easily and may be detached if touched with an even slightly oily finger, or jostled together in the killing jar. Leidoptera should, therefore, be handled with forceps. A broad smooth stamp-forceps special tools for collecting them are correspondingly small and fine. The best net is of silk gauze, and need be no more than six inches across, with an eighteen inch handle. A killing bottle should contain, at most, three or four moths at once, so several very little vials should be provided. Carry a cork-lined storage box and a supply of "minute nadeln," insect pins about half an inch long and scarcely thicker than a hair. Some collectors prefer pins of standard length, number 000, but these bend so easily that they are a nuisance to handle ever after. Pin the specimens as soon as they are removed from the vial, separating the wings and fluffing up the fringes by blowing on them gently. If possible, spread "micros" on the day of capture. If it is too inconvenient to pin the insects in the field, leave them in the killing vial, which should be very slightly damp, until your return, and then pin immediately. Even with the best of care, it is probable that only about half your catch will be fit to keep by the time it is mounted.

True flies also require special attention in the field. Not only are they often delicate in structure, but

many of them are covered with fragile hairs and spines which are necessary for identification. No heavy or vigorous insect should be put into a killing jar with flies. For the best specimens, use several small killing vials, reserved for Diptera only. With husky species, such as Horse-flies and some Flower-flies, it is safe to fill the vial to capacity and leave it so all day. If it is as much as half full, the natural moisture of the specimens will keep the catch pliable until you return to your base, where you can empty the bottles and mount the specimens in one operation. The less often you handle Diptera, the more perfect they will be. In some groups of flies the male genitalia are used in making an identification and should be pulled out into plain sight at the time of pinning. If the catch consists of frail, pilose, or spiney species, not more than a dozen specimens should be put into a bottle at one time, and these should be removed within two or three hours at the most. Very particular dipterists may carry pins and cork-lined storage boxes with them, pinning their specimens in the field. Others pack theirs between layers of cotton in pill boxes.

May-flies and some other ethereal creatures are on the borderline between the hard-bodied and the soft-bodied, and may be treated as either. Some students keep them in alcohol. Others pin them while fresh, or dry them unmounted and subsequently glue them to the sides of the pins without relaxing.

Grasshoppers and katy-dids, dragon-flies and other thin skinned, bright colored, but heavy bodied insects present a problem. Due to their bulk they dry so slowly that the abdominal contents decay and stain the specimens. Methods of preventing this are varied. Forced drying is one. Evisceration and stuffing is another. Dragon-flies are sometimes placed alive in envelopes and starved to death, a process perhaps not so barbarous as it sounds, since it requires a few hours only. Alternatively, they can be collected into concentrated alcohol. After two weeks in this bath they will be almost entirely de-hydrated and, when pinned, will dry immediately. Green pigmented species, mantises, katy-dids and others, keep their color best if killed and kept for several weeks in a 2% solution of formaldehyde before pinning.

Stone-flies, lace-wings, and other large-winged, slight-bodied insects fit most readily into envelopes; bees and wasps, bugs, and other compact creatures, into cylinders or between layers of packing in a box. Directions for mounting large-winged species are given in Leaflet Number 5.

SWEEPING

The exceedingly rich but largely invisible fauna of thick foliage can be captured wholesale by swinging a net back and forth through herbage, or dragging it quickly through bushes and the leaves of trees. In order to withstand this violent treatment, a sweeping net is made of strong muslin with a heavy rim and short, thick handle.

The catch obtained by this non-selective method consists of assorted botanical fragments, spiders young and old, beetles, leaf-hoppers, true-bugs, grasshoppers and oddments of other orders. In all probability, only a portion of this conglomeration will be of interest to any one collector, and you may have some trouble in selecting from the seething mass the specimens you want. You can, of course, just open the net and peer inside, trusting to luck and your own dexterity to sieze the valuable specimens while allowing the others to escape. You can dump the whole lot into the killing jar and cart it home to sort at leisure, thus needlessly slaying a great many harmless creatures. Or, you can shake the entire catch into the bottom of the net, secure it with a twist, and put net and all into a large killing bottle just long enough to anesthetize the animals. Then empty the net onto a cloth, or any clean surface, pick out the specimens you need, and drop them back into the killing jar or alcohol bottle as their sturcture may indicate. The rejected remainder will soon revive, little the worse for the experience.

Collectors who do a great deal of sweeping sometimes use a separator to facilitate the sorting process. This separator is a box, large enough to contain several handfuls of leaves and having, near the top of one side, an opening at which a glass bottle may be attached. The top of the box is removable, so that it can be emptied easily. In the center of the lid is a hole, with stopper, through which the contents of the sweeping net are introduced. Most of the creatures inhabiting foliage are positively phototrophic; that is, they seek the light. They have, moreover, a tendency to climb upward. When enclosed in a dark box they will crawl up toward the light which is admitted only through the glass bottle. When the bottle becomes at all crowded, it is replaced by an empty one. The vegetable debris which remains in the box is removed frequently, before it becomes so tightly packed that the creatures have difficulty in squeezing through it.

Separators are not sold by the scientific supply houses, and if you want one you will have to make it yourself. Remembering the principle by which it works, you can use whatever materials are most convenient to you. The separator shown in fig. 6 is made of a large metal cracker box, such as some grocers use. The glass bottle is a pint canning jar, the kind with a flat glass lid held down by a threaded metal rim. This rim is soldered to the box, and surrounds an opening almost as large as the mouth of the jar, which can thus be screwed onto the box in a moment, and just as readily replaced by a similar jar. The receiving hole in the lid is equipped with a wide-mouthed

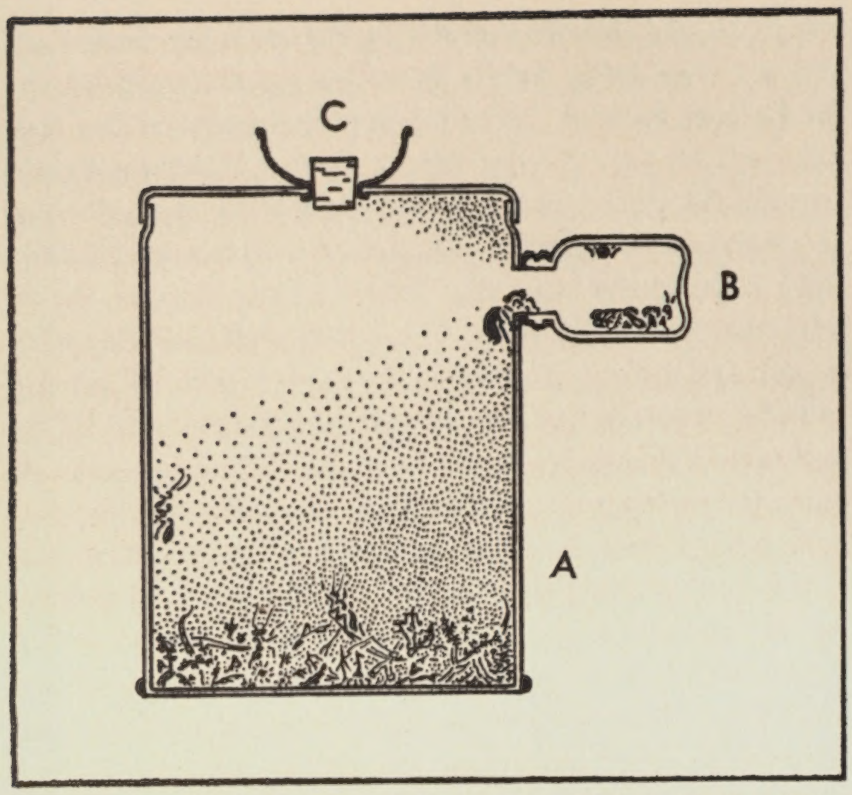

Fig. 6. Diagram of a separator for collecting positively phototrophic insects and spiders.

A. Metal box containing sweepings.
B. Replaceable glass jar.
C. Receiving hole with funnel and cork.

funnel, made for filling canning jars, and is closed by a large cork.

Sweeping is most successful in neglected fields, abandoned meadows, marshes and the edges of woodlands. In the deep forest, or in grazed and cultivated areas, it is less productive. More insects are taken by this means in the early morning and late afternoon than in the middle of the day.

BEATING

Many insects not otherwise obtainable can be jolted out of trees and large bushes by thumping the branches vigorously with a club. The specimens dislodged will inevitably be lost unless provision is made to receive them. The larger the receptacle provided, the greater the proportion that will be captured. If a party of collectors work together, they may appoint one member to do the beating while the others station themselves around a bed-sheet spread upon the ground, ready to sieze whatever may fall onto it. An individual collector will probably prefer something less cumbersome, a square yard of muslin or a bridge-table cover, for instance. So small a beating sheet is more efficient if it can be spread upon a light collapsible framework and held immediately under the branch which is being beaten. A very simple frame is shown in fig. 7. It consists of two strips of wood crossed at right angles and feastened at the intersection with a small bolt and wing-nut. Such an arrangement can be improvised in the field with a couple of saplings and a piece of twine. The cloth is fastened to the frame by means of tapes or loops of strong elastic sewed fast to the corners, and can be as large as you care to manage. An ordinary big black umbrella with a crooked handle makes a serviceable beating cloth, if held bottom up; while the crook is handy for pulling down branches too high to reach unaided. The black color may be an advantage, as it is said that, although they are harder to see, the specimens are not in so great a hurry to leave a black cloth as a white one. A sweeping net will also serve and, though rather small, it is so deep that few of the specimens which drop into it are able to climb out before you can sieze them. The beating net, wide, shallow, heavy, and very strong, serves as both cloth and club. It is operated by ramming its rim against branches and the trunks of slender trees, but it is so exhausting to handle that few collectors find it worth the effort. Beating is most productive when applied to solitary trees, or to those in hedge-rows and at the edges of woods. Dead and ailing trees should be beaten, as well as flourishing ones, since they attract a different fauna. Blooming trees are particularly rich.

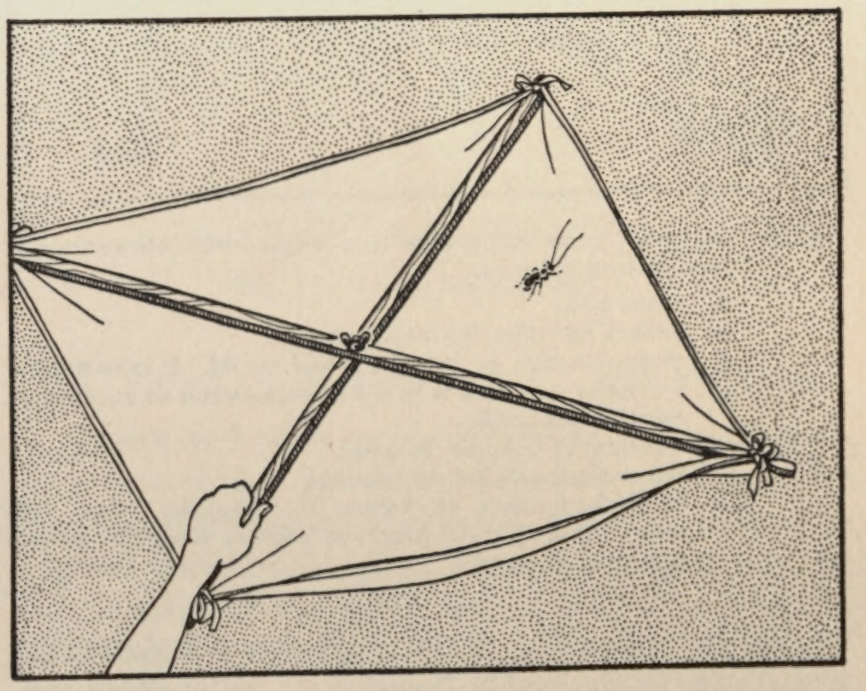

Fig. 7. A simple collapsible beating cloth.

AQUATIC COLLECTING

The insects which cling to rocks, pebbles, logs, and plants beneath the surface of water can easily be caught with forceps, once seen and brought within reach. Half-submerged tree trunks and rocks too large to lift must be inspected as well as may be possible where they lie, but stones, sticks, and vegetation small enough to handle can be picked up and examined thoroughly. When exposed to air, the specimens will soon betray themselves by their activity. Approach the swimming species suddenly, from below, using a dip-net, or a kitchen sieve lashed to the end of a pole. Drag this net through aquatic vegetation to secure the beetles and bugs which lurk in such places. In still water, the bottom-dwelling forms may most readily be taken by dredging with a scrape-net, which is flat

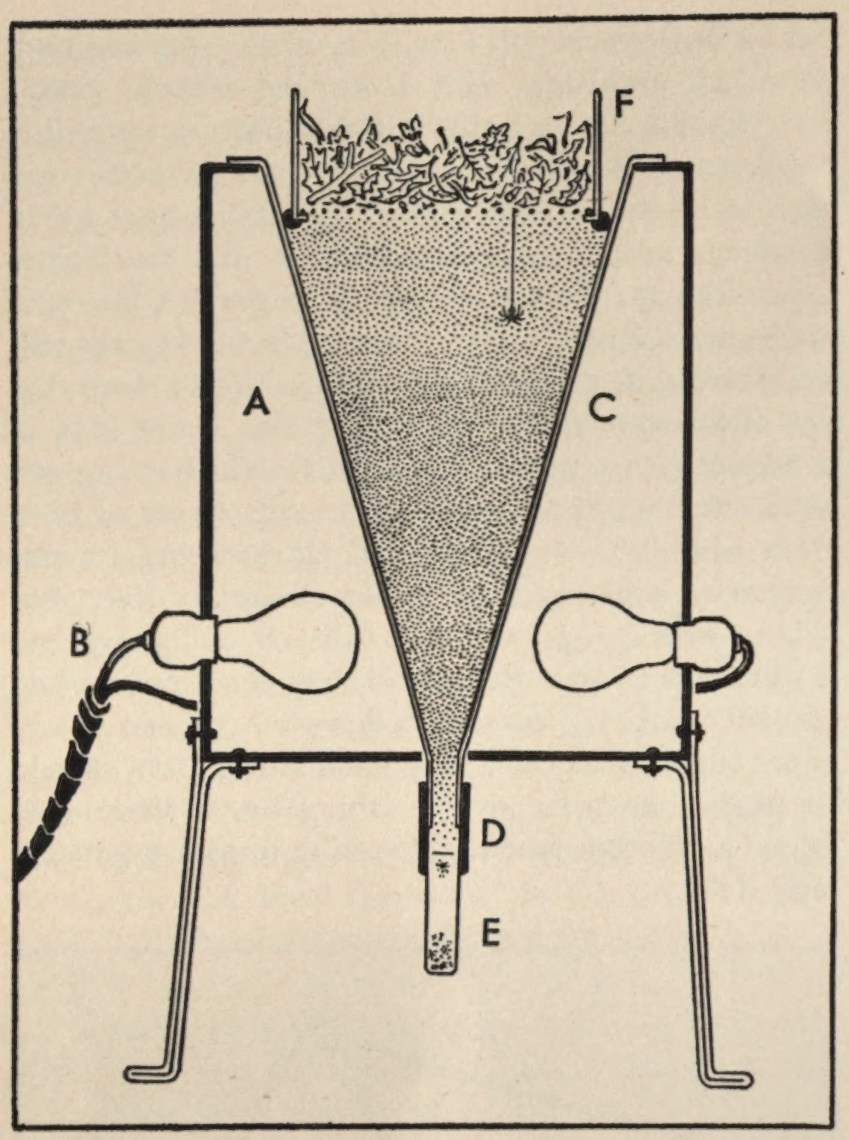

Fig. 8. Diagram of a separator for negatively phototrophic insects and spiders.

- **A. Tight box.**
- **B. Lamps to heat the separator.**
- **C. Funnel, made of thin polished metal. It is separate from the box and is lifted out when it is necessary to reach lamp bulbs.**
- **D. Section of rubber tubing.**
- **E. Glass shell vial full of alcohol.**
- **F. Mesh-bottomed container for debris. You will want several, with mesh of various sizes for debris different fineness.**

on the bottom edge. Both these nets are described and illustrated in Leaflet Number 2. In shallow running water, hold the net in one hand, with the lower edge of the rim pressed against the bottom and the mouth of the bag facing upstream. Just above the net, stir the mud and agitate the stones with the other hand. The creatures so disturbed will be carried into the net by the current; the mud and smaller vegetable fragments will wash through the mesh.

Derbis left on the shore by a recent flood, freshet, or spring tide, may be simply swarming with insects washed out of their inundated homes. So also may the flotsam caught in a whirlpool or eddy. If an inspection convinces you that such is the case, it will repay you to shovel the derbis into a burlap bag, drain it, and put it into a separator to extract the creatures, most of which, unlike those taken in sweeping, are likely to be negatively phototrophic. That is, they will seek darkness, and crawl downward in the search. Accordingly, the separator required must work on opposite principles from the light separator described above. One such device is called, after its inventor, the Berlese Funnel. As the name indicates, it is a funnel, very large. At the top is a wire mesh basket to contain the deris; at the bottom, a bottle of alcohol to receive the specimens. The insects, distressed by the light from above and the drying of the debris, try to bury themselves further. They fall through the wire mesh, and being unable to keep a foothold on the polished interior of the funnel, drop into the bottle and are automatically collected. This process is hastened by warming the funnel. Berlese used a water-bath heated by a Bunsen burner for this purpose, but a box full of lamps, or some other electrical contrivance, would be just as effective, and easier to make. This separator is shown in fig. 8. It works as well for leaves and leaf mold, moss, lichens, bark and fungi as it does for flood debris or soil samples.

When working in the vicinity of water, do not neglect to look inside culverts and on the undersides of bridges, as well as among leaves in shady places, for the adult forms of species whose larvae inhabit the adjoining streams and ponds.

SIFTING

The many insects and spiders living among fallen leaves, rotton wood, fungi, and other moist, rich, fragmentary matter are, on the whole, so small and inconspicuously colored as to escape attention in their natural surroundings. As described above, they can be efficiently extracted by use of the Berlese separator. Less comprehensive but more immediate is the process called "sifting," whereby the creatures are shaken out of their hiding places on the spot. The necessary tools are a deep large-mesh sieve and a cloth onto which the specimens may fall. If you have a beating cloth, that will do. If not, get a somewhat

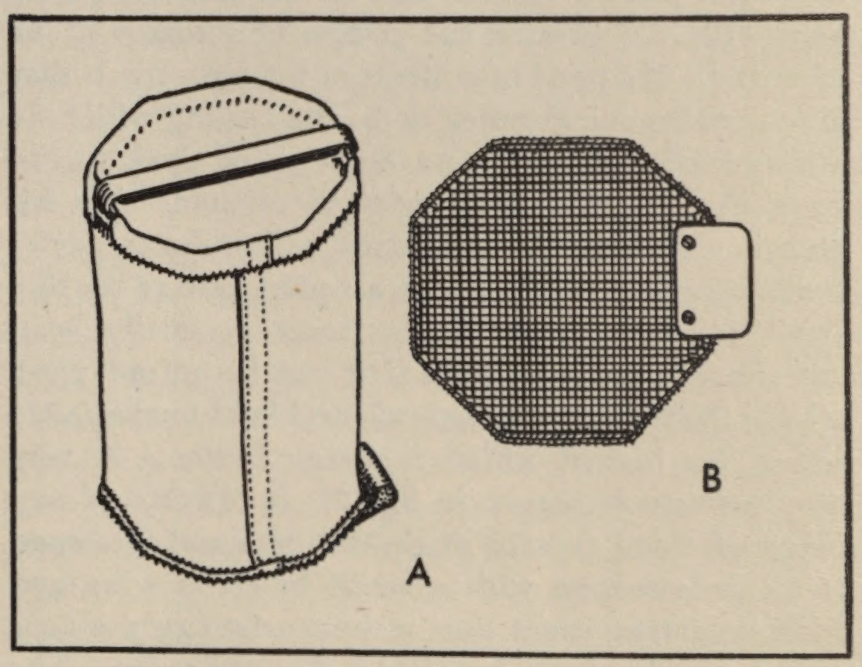

Fig. 9. A collecting sieve. The shape and size are optional.

- **A. The sieve showing handle.**
- **B. Bottom, showing wooden grip.**

smaller one. A piece of white oil cloth about two feet square is excellent, being easy to clean and handy to sit on in damp places when not needed for its proper purpose. The sieve can be a wire basket, such as is used in making french-fried potatoes, or a specially constructed one designed for collecting. Such a sieve is shown in fig. 9. It is a canvas sleeve about 14 inches deep and 12 inches across, having in the bottom a hexagonal piece of ¼ inch galvanized iron wire mesh, and at the top a galvanized iron wire hoop crossed by a convenient handle. Although not strictly necessary, a small wooden grip bolted to the edge of the mesh at the bottom of the bag is a great comfort to the hands of the collector. Precise directions for making this sieve are given in Leaflet Number 7, together with those for separators, traps, and other special equipment.

When using the sieve, fill it to a depth of about four inches with debris. Holding it over the middle of the sifting cloth, shake the screen violently from side to side a few times. A sprinkling of dark fragments will fall through. Put the sieve down on a corner of the cloth, take up the alcohol bottle and brush, and concentrate upon the specks. When one of them moves, grab it. Do not be impatient. It will be several minutes before all of the creatures stop "playing 'possum," and begin to leave. When you think you have them all, pick up the sieve, dust off the cloth, and shake again. Four shakings usually suffice to exhaust a lot of debris. Then empty the sieve and start over.

Sifting is most productive if the sifted material is gathered in a shady place which is always moist, but not wet. In the autumn, fungi of various kinds are especially populous. These can be shaken in the sieve, or held over the cloth and thumped.

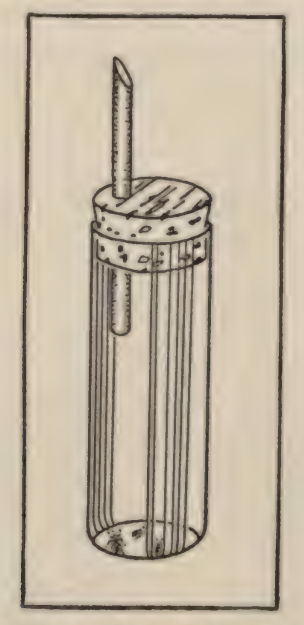

Fig. 10. A quill bottle.

Fig. 10 shows the quill bottle, a device alternative to the wet brush for picking up minute hard-bodied species. It is a vial with a shallow cork through which a hole has been bored near one side. A piece of the quill of a large feather, or its equivalent in thin plastic tubing, passes through this hole, fitting snugly. The outer end of the quill is cut off diagonally, making a small scoop with which the insects can be shoveled up. The inner end of the quill projects beyond the cork far enough to prevent the captives from falling out through it when the bottle is inverted. The quill bottle must be emptied into a vial of alcohol from time to time.

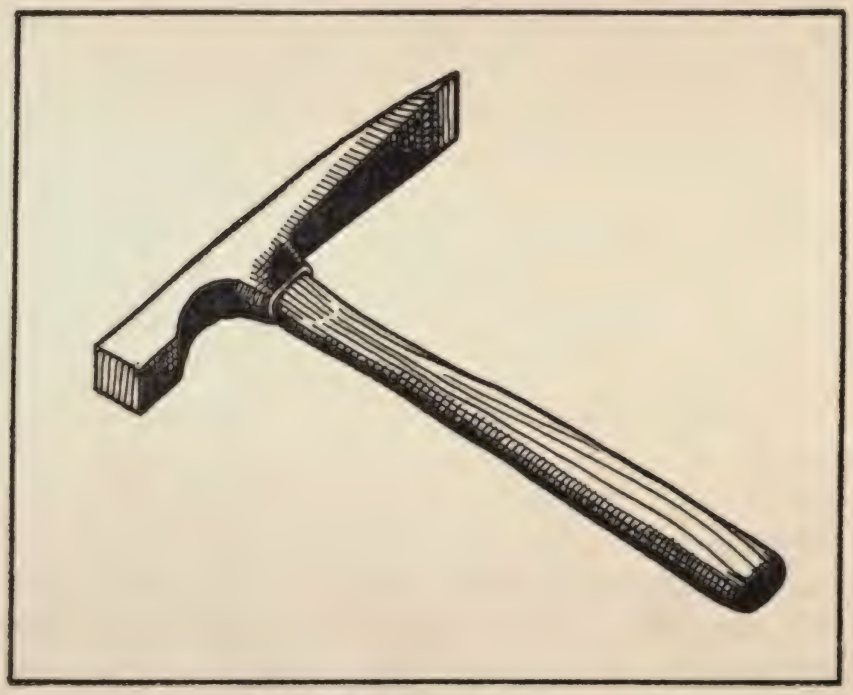

Fig. 11. A Mason's hammer.

COLLECTING BURROWERS AND BORERS

Insects and spiders which burrow in the ground, or in the stems, branches and roots of plants, are discovered largely by hard work and a sound knowledge of the habits of the beasts. Sometimes you are lucky enough to sight one abroad and follow it home, but usually you just have to guess where you would be at this time of day if you were a digging wasp or a roundheaded borer, and then go there and look. This entails the expenditure of elbow grease and the use of some sort of digging tool. For soft earth and sand a garden trowel is satisfactory. A mason's hammer or small geologist's pick is invaluable for breaking hard soil, prying up rocks, splitting wood, and tearing the bark from dead trees. It is shown in fig. 11. A strong sharp knife is necessary for digging borers out of wood, and for splitting twigs and the stems of herbaceous plants.

The sides of streambanks and road cuttings, ditches, gullies, or any other place where a considerable vertical expanse of earth is exposed is likely to attract digging wasps, bees, spiders and other creatures which nest underground. Even when there are no external openings, it may repay you to slice off the face of such a bank with a shovel. If there are any inhabitants, their tunnels will then be visible, and you

can follow them up with a trowel or a knife. When excavating nests, especially those of ants or termites, be on the watch for parasites and inquelines.

Species which live at the edges of ponds and streams can be flooded out of their burrows by dipping water over them till the earth is saturated. Those which live in mud already sodden, or even slightly submerged, are to be routed out by the messy but practical process known as "bog trotting." This consists of tramping through the vegetation, muck, and shallow water of marshes, and at the edges of sluggish streams and stagnant ponds, creating as much disturbance as possible. The insects, mostly ground-beetles, thus rudely aroused, will shortly appear on the surface of the mire, headed for solid ground, or climbing up the stems of plants or the legs of the collector. Since the creatures are swift, you will be more likely to see them in time if you walk backward, watching your wake, and inviting a mud bath. Wear your oldest clothes, and sneakers or hip-boots. Carry a minimum of equipment. The true, or quaking, bog is a dense mat of small living plants, growing on top of water from the shore outward, and sometimes completely covering a lake or pond. Although far from rigid, it is often thick enough to bear the weight of a man. If so, it is easy to drive out its numerous and largely coleopterous inhabitants by standing still. As the mat of vegetation sinks under your weight, the water, seeping through it, forces the beetles upward until you find yourself ankle deep in a puddle upon the surface of which your victims are haplessly floating. Experts who are addicted to marsh and bog collecting claim that it is so richly rewarding as to justify the personal discomfort which may attend it.

In the season when night-flying beetles are abroad, great numbers can sometimes be unearthed by digging under an illuminated sign board, where the creatures, attracted to the light at night, have dug themselves in to pass the day. This is especially fruitful if the lights are blue, and far removed from other brilliant illumination.

When spading a garden in the spring, you are certain to unearth insects which lived upon the plants grown there during the preceeding summer. A great many of these will be in the pupal state, but if kept in damp soil will soon mature and yield perfect specimens. Digging at the foot of a large tree will probably reveal the pupae of species which, as larvae, fed upon its leaves. Plants observed to be ailing without apparent reason may be suspected of having borers or other insects at the roots.

The earth under a carcass is likely to harbor insects feeding upon seepage from the carrion. These may be tidily extracted by shoveling the soil into a pail of water. As the clods melt the insects rise to the surface, whence they can be harvested with forceps. The same procedure can be employed with cow-chips and the excrement of other animals, with the soil under an accumulation of dung, or with compost or earth of any kind which is likely to contain desirable specimens.

In arid regions the insects and spiders, like other animals, seek shelter from the mid-day heat by hiding in the coolest, dampest, and darkest place they can find. For many of them, this means among the roots of plants. If the plants of the desert are pulled up, and the roots shaken, a surprising number of creatures may be uncovered. The hollow stems of dead weeds also afford temporary shelter to nocturnal species.

Square-heads, long-horns, and other boring insects, beetles, moths, and saw-flies, when young may inhabit solid wood. They are especially difficult to get at without doing damage to the specimens, and unless you have strong evidence of a heavy infestation, or are particularly interested in the larval stages of these creatures, you will be wasing your time to try. If you get them, you will probably have to rear them before they can be identified exactly. The adults are often taken by beating dead and dying branches.

TRAPPING

Trapping is the easy way of catching many elusive kinds of insects, most of them nocturnal. The traps range from an artful multiplication of natural hiding places to elaborate contraptions comprehensible only to their inventors. You can, for instance, "plant" flat stones, sheets of bark, and pieces of board in likely spots and wait in the hope that species normally found in such places may take up residence. In such favorable locations as deserts and the barren tops of mountains they may do so overnight. In verdant areas, where there is plenty of other shelter, it may be weeks or months before conditions under the "plants"

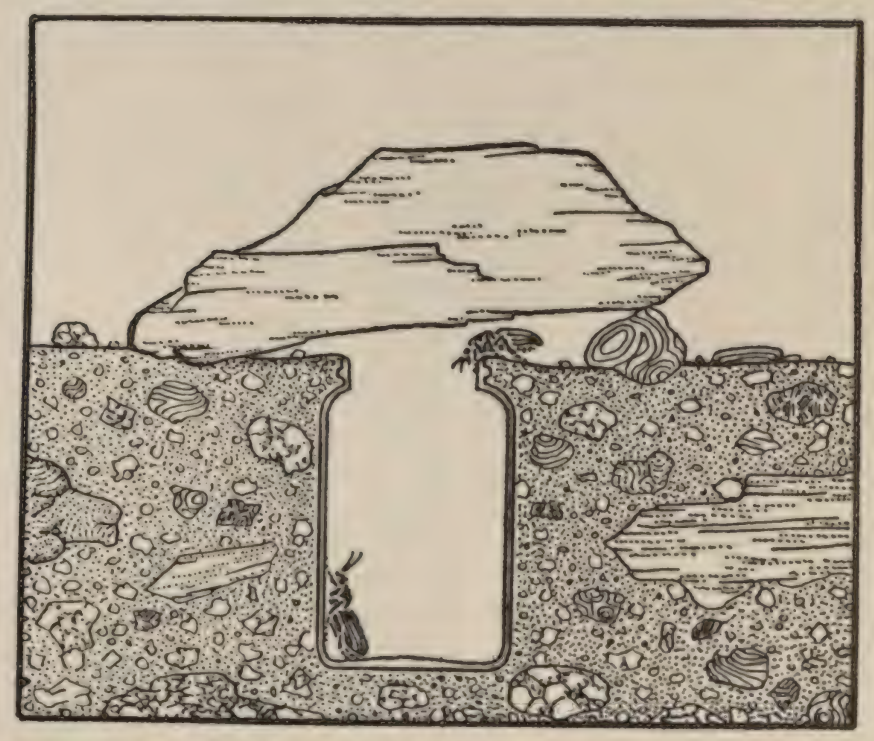

Fig. 12. Diagram of a simple trap, made by burying an empty jar.

become sufficiently attractive. In the autumn, when the insects are looking for places in a which to hibernate, exceptionally fine catches are to be expected. At this season,a band of cloth wrapped around a tree trunk will also shortly be inhabited. If you are interested in ant guests, put a slab of wood over every ant-hill you can find. In a few weeks the ants will have formed, under some of them, galleries which are open to inspection every time you care to lift the lid. Bark beetles and borers which infest dying and dead trees can be attracted by cutting branches of appropriate trees and hanging them up in some place convenient to the collector. As the sap ferments and the wood dries, there will be a succession of visitors which you may capture by beating the branches at intervals.

Assorted small carcasses, or bits of larger ones, if exposed in remote places, will summon carrion-beetles, rove-beetles and many other insects to the feast. If you leave them where the civic sanitation committee can find them, however, they will never get ripe enough to reach maximum efficiency.

Insects which are pedestrian by habit are often taken in an empty wide-mouthed bottle or tin can, buried to the lip in the earth, and shielded from rain and light by a stone or piece of wood sufficiently elevated to allow the insects access to the trap. Once in, they cannot climb out, and so remain until you call for them. The efficiency of this arrangement is increased by baiting the jar with a bit of rotten meat, or with a sweet fermenting syrup such as is described below for use in "sugaring" for moths. Specimens which drown in syrup have to be washed with water before mounting. Traps of this kind must be inspected every two or three days, if the specimens are to be found in good condition.

The Rummel trap, devised by a skilled professional collector, is effective for the capture of some flying species which do not come to lights; and it is relatively easy to construct. As shown in the picture, fig. 13, it consists chiefly of a cylinder of wire screen covered by a solid lid. It stands upon three or four feet which elevate it about three-quarters of an inch. inside of the cylinder, and fitting it at the bottom edge, is a cone of wire screen with an opening three quarters of an inch across at its apex. Under the cone is a saucer filled with fruit stewed in sugar and allowed to ferment, a process which may be hastened by the addition of a little yeast. The insects, attracted by the smell, crawl under the edge of the cylinder, between the feet. When they have fed to repletion, they fly upward. Striking the screen, they crawl through the central aperture into the covered cage, where most of them go to sleep. It is convenient to build this trap to fit inside a five gallon covered paint pail, made into an anesthetising chamber on the principle of the ethyl acetate killing jar. Before opening the trap, place it in the pail for a few minutes, to quiet the specimens, then dump them onto a sifting-cloth for sorting. The pail also serves as a carrying case for the trap, and as a stand upon which to set it while in use.

Success in using this trap depends upon selection of an advantageous station, usually one on a stump or rock in open woods. Forest paths and clearings are especially appropriate. The season and atmospheric conditions also influence the catch profoundly, warm, still, humid weather being most satisfactory. More specimens enter the trap during the twilight hours of dawn and dusk than at other times, least during the heat of the day. Most of the creatures attracted to the trap are moths and butterflies, although there will be some beetles, bugs, and a few other kinds of insects among them. For perfect, unrubbed specimens, inspect the trap daily. A trap line of ten or a dozen traps may be profitably maintained from early spring to late fall.

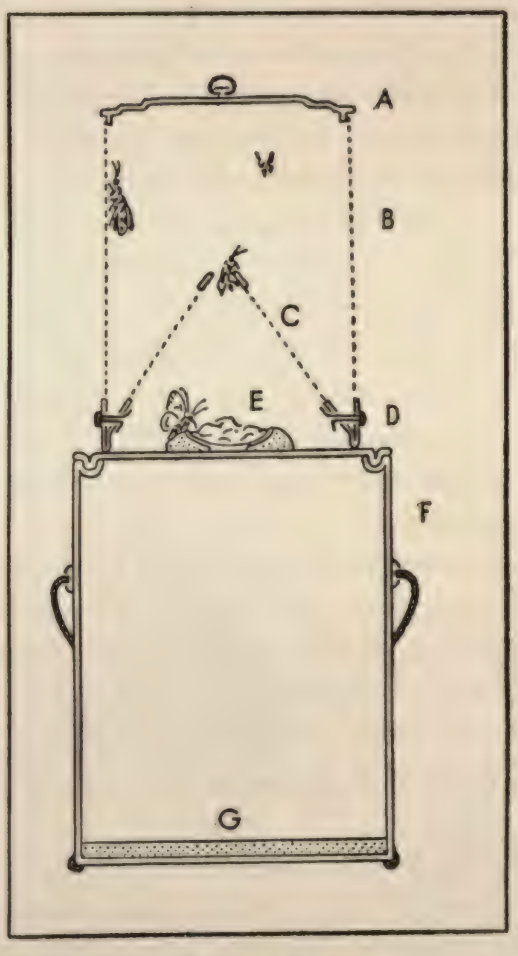

Fig. 13. Diagram of the Rummel Trap.

A. Tin pot lid.
B. Wire screen cylinder, soldered to rim of lid.
C. Wire screen cone, to which are soldered the feet made by bending a strip of thin metal into an appropriate shape.
D. Cotter pins passing through holes in the feet and fastening the cylinder and the cone together. Trap is opened by removing these pins.
E. Saucer set in plaster of paris and containing bait.
F. Five gallon paint pail.
G. Layer of plaster to absorb the anasthetic used to quiet the specimens for sorting.

NIGHT COLLECTING

Although some nocturnal insects are taken in traps, or found asleep or in hiding during the day, night collecting amply repays the extra effort which it may demand.

The principal difference between diurnal and nocturnal collecting is that, at night, the collector must provide his own light. For some purposes, a strong flashlight is adequate. The gasoline-burning Coleman Lantern is exceedingly efficient in shedding a brilliant illumination over a larger area. An electric headlamp, with focussing beam, is much esteemed by some experienced collectors. It has the double advantage of freeing both lands, and concentrating its beam, and the wearer's attention, on a comparatively small area. It is especially valuable for locating spiders, as their eyes, like those of some insects, are chatoyant; that is, they reflect the light which falls upon them as points of vivid color. In the concentrated brilliance of the headlamp, every spider within range, if looking in your direction, springs to your attention instantly.

Nocturnal collectors will find it both pleasant and convenient to work in pairs or trios, one to carry the light, one to hold the killing bottles, and possibly one to swing the net. Other equipment can be distributed among them, and the party will thus be prepared to perform effectively any collecting operation which may be required.

Any collecting technique which is effective by day can be practised at night with equal or superior results. Active diurnal species, particularly grasshoppers, will be found clinging to the stems of tall grasses, quietly asleep. Leaves, flowers, and crevices also shelter a slumbering multitude, flies, beetles, dragonflies, and others, all of which can be had for the trouble of picking. On the other hand, nocturnal species will be awake and busy. Adult beetles, which as larvae bored in wood, will be found walking over the bark of dead or dying trees. Beating and sweeping are both especially productive in the twilight, at which time the nectar-drinking moths also appear.

The irrisistible fascination of the flame for the moth is proverbial, and although not all the insects so attracted are moths, nor are all moths affected, it is the basis of the most familiar nocturnal collecting technique. Even in cities, street lamps, porch lights, and illuminated windows attract a surprising number and variety of insects. In the country, remote from other sources of illumination, a single lantern may bring in thousands in a single night. As a collector, you can use this fact in several ways. You can simply hang up your lantern in a tree and stand beneath it, net in hand, awaiting what may appear. You will get a good many moths by this method, but you will lose most of the beetles and other insects which drop to the ground when they reach light of a certain intensity, instead of flying right into the flame as a moth will. If interested in such creatures, you will do much better to spread a sheet or canvas on the ground and set your lantern in the middle of it. The white cloth intensifies the effect of the illumination; and the dark specimens, falling upon it, are easy to see and sieze. You will find a flashlight useful for recovering specimens which drop beyond the edges of the sheet.

If you have a car you might try this. Hang up, a sheet over a high wall, or tie it to a horizontal branch. With pins, turn up the bottom edge to form a gaping

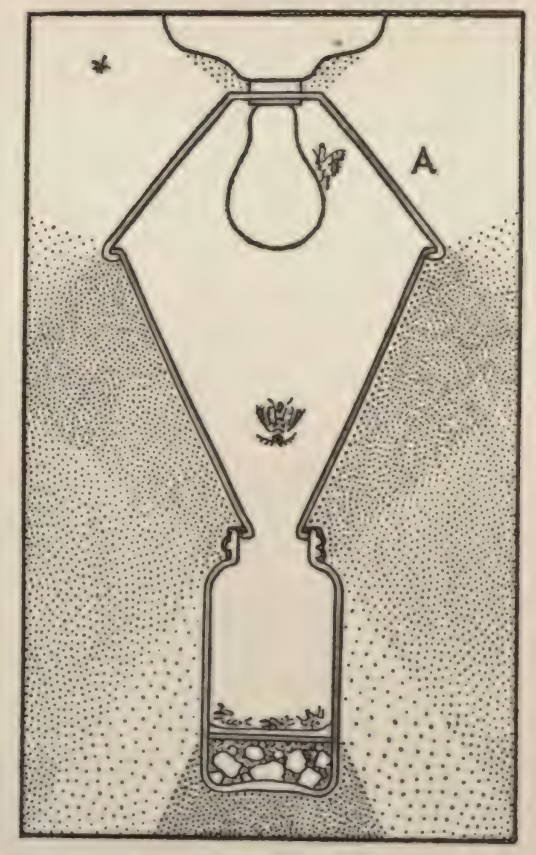

Fig. 14. Diagram of a simple light trap.
A. Wire lamp-shade frame to support funnel.

pocket about a foot deep. Train the headlights of the car upon the sheet. The reflected light will attract numerous insects, most of which, when they strike the cloth, will drop into the pocket, whence you can remove them before they have a chance to climb out.

Automatic light traps, which kill indiscriminately every insect which falls into them, are almost as numerous as collectors. Many kinds are described in technical literature. A very simple one is shown in fig. 14. It consists of a quart-size cyanide jar with a large metal funnel at the top. This is suspended immediately under a lamp, which may be one provided for the purpose or a porch, garage, or other outdoor light to which the trap is an incidental appendage. For the construction of this trap, see Leaflet Number 7.

In addition to the lack of selectivity, automatic light traps have another drawback. They are too efficient. Under favorable circumstances they attract so many insects that, even if the jars are emptied

frequently, the specimens are almost sure to rend, rub, and crush one another before they are removed.

"Sugaring" is another traditional method of nocturnal collecting. It is employed chiefly for moths, although a few other insects do come to the bait. The idea is to distribute a sweet odorous syrup in likely places, and wait for the specimens to come to supper. In practice, it goes like this:

Obtain a quart of molasses and, if need be, thicken it with brown sugar until it is distinctly "slow." To improve the allure, spike it with a little rum, stale beer, spoiled fruit juice, or asafoetida. It is difficult to understand how any creature could enjoy asafoetida, but the insects appear to do so! Put this mixture into a paint pail or other readily portable container and, armed with a paint brush about two inches wide, set out late in the afternoon to lay your trail. This trail should be a circuit around which you can walk in half an hour or thereabouts, leading through forest paths, along the edge of marshland or in any place where trees are plentiful but not dense, and the footing is sure. Remember that you will be making the rounds after dark, and will not be thinking of avoiding pitfalls. At intervals of 15 to 50 feet around the course, select accessible trees, not too rough of bark, and at the most convenient height paint upon each trunk a patch of syrup about as big as your hand. If the trees are so thick that you anticipate trouble in finding the right ones in the dark, mark them with strips of white adhesive tape, or with slips of paper fastened with thumb tacks. When the circuit is completed, return to your base and provide yourself with several moth-killing bottles, large and small, one jar for other insects, packing boxes, labels and pencil, forceps and aerial net, and a good strong flashlight or lantern. If possible, secure the services of an accomplice to carry the lamp and net. If you use cyanide bottles, fortify each by pouring a teaspoonful of ether or ethyl acetate onto the porous bottom filling, for quicker action.

As soon as dusk has fallen, begin to walk around the trail, inspecting each baited tree with the flashlight as you go. You will find the insects sitting on the bark, their probosces extended into the syrup like straws into a soda. Some of them will start away as soon as a bright light falls on them. These you must take with the net if you can. Some of them will be, at least to all appearances, quite drunk. These you may knock into the jar with a flick of the finger. If the collecting is good you will be strongly tempted to overcrowd the killing bottle. Don't! Take the time to pack the insects properly. If you cannot leave them in the killing bottle long enough to be sure they are dead, put a little killing fluid on the packing of the storage boxes to finish them off. Continue making the rounds until your feet give out, the moths go back to sleep, or the packing boxes are all full. Like other nocturnal collecting, sugaring is most successful on nights when it is hot, humid, dark and still. Cool, windy, or brightly moonlit nights produce few insects.

WINTER COLLECTING

Many amateur collectors seem to think that, with the first frost, all the insects and spiders de-materialize. This is not true. Adults of some species do die in the autumn, but their eggs survive, and can be found by the observant and interested collector. They are often very beautiful and worthy of attention. Other species pass the winter in the mature form, or as larvae, nymphs, or pupae, hidden in snug underground chambers, beneath debris, under bark, in caves and hollow trees, under stones, in attics, cellars, and outbuildings, or in almost any nook or cranny into which they can contrive to wedge themselves. All of these you can find if you care to take the trouble. Do not, however, make the attempt in really cold weather. The colder it is, the deeper the creatures bury themselves. Wait until a sunny day when the temperature is a little above freezing or, better yet, one after a succession of such mild days. The insects will then be astir, albeit sluggishly. You will find a few hardy species sunning themselves in the open. Many more will have come almost to the surface, and can be taken by sifting, digging, turning over stones, and stripping loose bark from dead logs. There are a few kinds of insects which are commonly seen only in the winter or very early spring. One, a springtail, is a minute species which you may see in great numbers hopping over the snow. Another is a stone-fly which matures while there is still a film of ice at the edges of the swift streams where its larvae live.

Truly domestic insects, which live in heated houses, and parasites infesting warm blooded animals, naturally are active the year round. Immature insects found in the winter can be brought into the laboratory for rearing if their food is such as is obtainable out of its proper season. And, when there is no collecting to be done, the serious student can spend his winter hours happily in mounting, sorting and, identifying his summer's catch.

PACKING INSECTS FOR SHIPMENT

Sooner or later every collector of insects and spiders will have to pack some, if not all, of his collection for shipment through the mail or by express. This is an hazardous undertaking, unless approached with extreme precautions, which differ according to the nature of the material.

Alcoholic specimens in vials may be treated in two ways. You can wedge them into the vials with wads of cotton to prevent violent agitation, fill the vials, cork them tightly, and pack them between layers of

cotton in a box; or, having secured the specimens with cotton plugs, you can pack the corkless vials, upright, into pint preserving jars, like asparagus spears in a can, fill the jar with alcohol, and seal it with a rubber ring. In either case, the container must itself be packed in a strong wooden or corrugated cardboard box large enough to permit of its being completely surrounded by a layer of excelsior or crushed paper several inches thick, as shown in fig. 15. If it is necessary to ship more than one jar in a box, separate them by a layer of packing. Do not make the boxes too heavy for easy handling.

Fig. 15. Diagram of a jar of alcoholic specimens packed for shipping.

Insects packed in paper envelopes and cylinders travel well, if housed in a crush-proof container. Of the thousands of shipments unpacked in the Department of Insects and Spiders, the most consistently satisfactory have come from South America in boxes scarcely larger than cigar boxes, but made of planking half an inch thick carefully screwed together. The papered specimens filled the boxes, with no more packing than was needed to keep them from shifting. If you find it necessary to use containers of questionable strength, ship them in larger cartons, surrounded with packing, as described above for alcoholic specimens.

Dried insects upon pins can be safely shipped in Schmidt boxes or other strong storage boxes of small or moderate size if steps are taken to prevent the pins from coming loose during the journey. With flies and other creatures light in weight it is only necessary to drive the pins into the cork bottom of the box securely. With Cicadas, large beetles, giant moths and other heavy species, further precautions may be necessary. A specimen of great weight may, if jolted violently, pull its pin free and go banging about among the rest of the collection working wholesale havoc. A simple method of preventing this is shown in fig. 16 Pin the specimens into a box, spacing them as evenly as possible. Drive the pins into the cork until they strike the bottom. Since the pins are of uniform height, their heads will then stand level. If an insect's body is long, brace it with an extra pin on either side to prevent it from swiveling about upon its pin, should it be shaken loose. Cut a piece of cardboard to fit the inside of the box exactly. If you like, you can equip it with a pair of adhesive tape tabs or a string loop handle, by which to lift it. Put this into the box, resting on the heads of the pins. Fill the space between the card and the top of the box with packing, and shut the lid. Now the pins simply cannot work free. An occasional leg or antenna which was loose when packed may come off in transit, but that should be the full extent of the damage. This method of packing is risky unless the pins are thick enough to be rigid. The force needed to drive the pins through the cork and the strain put upon them in pulling them out, to say nothing of the pressure of the packing upon any which might be slightly higher than the others, are sufficient to bend a fine pin like a bow. And, like a bow, when the tension is released the pin will straighten with a snap, breaking

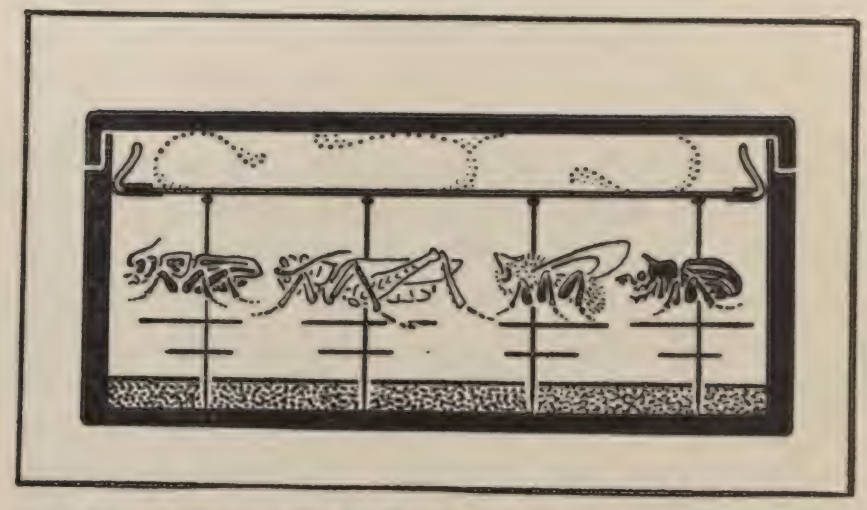

Fig. 16. Diagram showing a method of packing heavy pinned specimens for shipping.

the insect and flinging its fragments like missiles among the other specimens. To reduce jarring and the possibility of crushing, enclose a box of pinned insects in a larger box and cushion it well.

ETIQUETTE FOR THE ENTOMOLOGICAL COLLECTOR

It is unfortunate, but inevitable, that any person known to be a collector of insects or spiders is regarded by the lay public as somewhat demented. It is the manifest duty of every right-minded collector to

convince such of the uninitiate as he cannot avoid that the mania is at least an interesting one, more worthy of curiosity than of ridicule. It is impossible to traverse any public place with an insect net without becoming the butt of jests and the victim of innumerable questions, mostly silly. A little courtesy, when it comes hardest, will go far toward mitigating not only your own suffering at the tongues of the philistines, but also those of other collectors who may come after you. Indeed, with sufficient patience, you may even make a convert or two, especially among the young. Children, if they spot you in the field, are certain to follow you everywhere with leech-like persistence and a flood of conversation. This need not be wholly disastrous, for if you cannot shake them you can put them to work. Explain what you are doing and ask them, quite seriously, to help. The casually curious will soon weary of turning over stones, or chasing grasshoppers, and will depart peacefully of their own accord. The few who stick it out will be sincerely interested, and so worth teaching.

When collecting in strange territory which is not an absolute wilderness, it is only polite to ask the owner's permission and, having received it, to treat his property considerately. If you pull up his vegetables, mow down his flowers, strip his trees, overthrow his woodpile, and, in general, leave a swath of devastation behind you, not only you but all other collectors will be anathema to him forever after. There is another reason for disturbing things as little as possible, and that is to keep the insects content to remain in the vicinity. It is an article of faith among the instructed always to replace a stone or board which has been overturned, as it may take months for conditions under a newly moved stone to become acceptable to insects. Needless to say, it is unethical to abstract specimens from another collector's trap, should you happen to find one. You might, however, leave a note in it, and so make the owner's acquaintance, to mutual benefit.

For the sake of others who may be working the same district, and out of personal liking for insects and spiders as animals, the considerate collector will not kill any harmless creature except for scientific purposes. The number of specimens of each kind which should be taken will depend upon the collector's interests and facilities. If your interests are general and your storage space limited, you may confine your catch to two pairs of adults of each species. If you are fascinated by the strange life cycles of insects, you will want to keep immature specimens of all ages. If you are making a distribution study, or working out a pattern of seasonal variation, you may want hundreds of specimens of the same species from different localities and of many dates. In any case, take all your really want, but let the others go. Like any other natural resource, the insect population, especially of large and conspicuous species and in well collected areas, is likely to suffer from abuse.